Segmentation and Tissue-Classification of the Visible Man Dataset Using the Computertomographic Scans and the Thin-Section Photos

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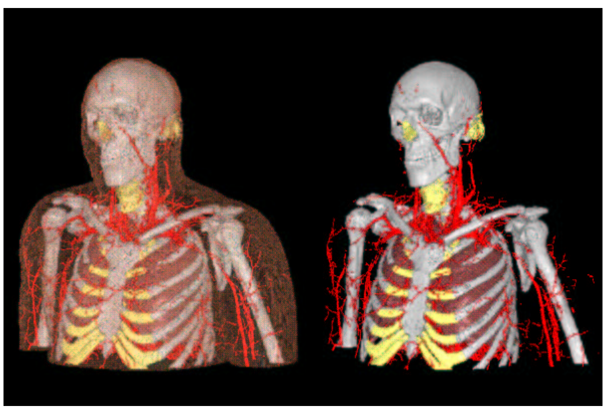
INTRODUCTION

Segmentation and classification are the major and most difficult steps in image analysis. Segmentation means that an image or a volume scan is divided into objects [3]. Classification is defined as the assignment of objects to pattern classes [2].

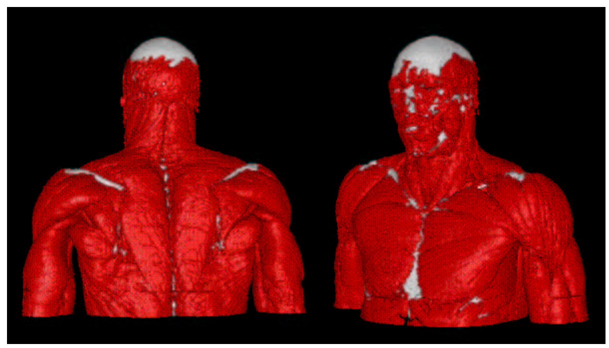


Picture 1: Segmentation of bones, bloodvessels, cartilage, a pair of lungs and skin.

The topic of this paper is the 3D segmentation and the tissue-classification of computertomographic scans and thin-section photos of the Visible Man dataset [1]. This yields information concerning the tissue distribution in human body. Knowledge of tissue distribution allows the creation of anatomical models of human body.
Anatomical models form a base of the Meet Man Project (Models for Simulation of Electromagnetic, Elastomechanic and Thermal Behaviour of Man). The purpose of this project is the creation of models to simulate the physical behaviour of man [6].

SEGMENTATION

Segmentation is the division of an image or a volume scan in objects, which are represented by homogeneous regions. The base of assessment of homogeneity are characteristics like color intensity, grey level, hounsfield value of computertomographic scans etc.. Characteristics can be combined and used to derive structural, spectral or statistical features.



Picture 2: Segmentation of bones and muscles.

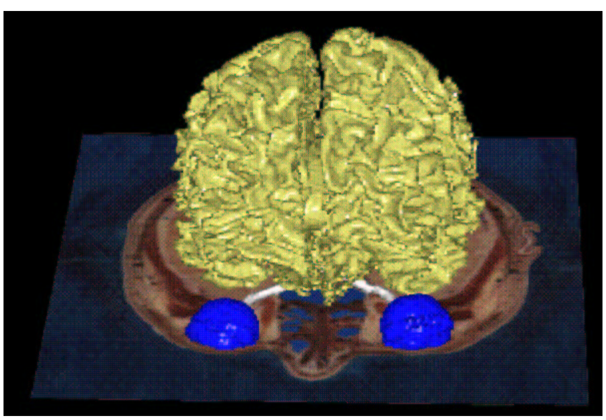
One common method to achieve a segmentation is the use of region growing strategies [3]. Region growing means that voxels are collected starting from a set of seed points. If their neighboring voxels (commonly the neighborhood of 6 or 26 voxels) match the region characteristics they are integrated within this region and are chosen to be new seed points. Region growing is an iterative process, finishing if no neighboring voxels fit in the region characteristics.
Another segmentation method is the splitting and merging of regions with the help of an octtree, the 3D equivalent of the quadtree [3]. The octtree is a hierarchical data structure that specifies the occupancy of cubic regions of object space. A cubic region, representing the whole object space, forms the node at the root of a tree. Any region within this tree is subdivided into eight subregions (which form eight child nodes in the tree) until their homogeneity of characteristics meets the requirements or until the size of the subregions corresponds to a given minimum size.

The segment representation of a volume dataset supports tissue classification. An improvement of classification results can be achieved considering the characteristics of segments, i.e. volume, moments of n-th order etc.. Manual classification methods can be simplified and accelerated by the decrease of segments [4].

Picture 3: Segmentation of fat, muscles and bones in the upper thight.

RESULTS

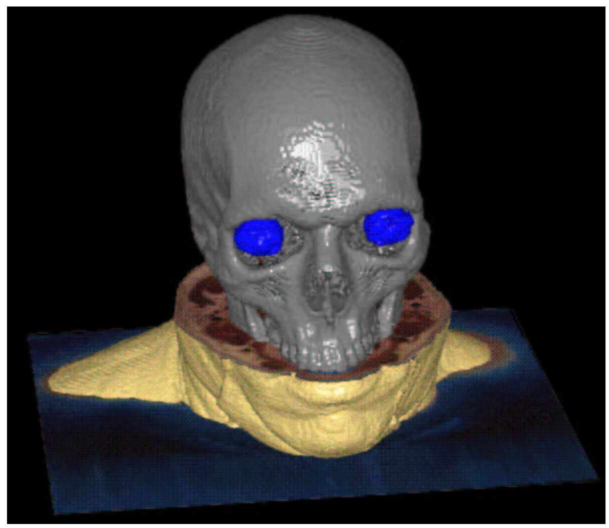
The described methods are demonstrated with a preprocessed volume dataset in voxel representation [5]. This dataset consists of matched computertomographic scans (CT data) and thin-section photos from the Visible Man dataset.



Picture 4: Segmentation of white matter, eyes and nervus opticus.

The CT data is filtered to enhance the significance of the characteristics. Using a median filter which works on the central voxel and its 6 neighbors, noise reduction and edge sharpening is obtained. In the thorax region a median filter in the yz plain with a 3 x 3 mask is used to reduce reconstruction artefacts in x direction.

Pictures 1 and 2 give a 3D representation of the segmentation in the upper body obtained by use of regiongrowing strategies. Picture 3 brings to view results of regiongrowing in the neigborhood of 6 voxels in the CT data and the thin-section photos of the upper thigh. Picture 2 shows white matter, nervus opticus and eyes as a result of applying regiongrowing strategies. Picture 3 demonstrates the segmentation of fat, bones and eyes in the caput.



Picture 5: Segmentation of fat, bones and eye.

ACKNOWLEDGMENTS

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